IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF TEXAS
WACO DIVISION

WSOU INVESTMENTS, LLC D/B/A BRAZOS LICENSING AND DEVELOPMENT, *Plaintiff,* **v.** **CANON, INC.,** *Defendant.*	**CIVIL ACTION 6:20-cv-00980-ADA** **CIVIL ACTION 6:20-cv-00981-ADA**
CANON INC., *Third-Party Plaintiff,* **v.** **NXP USA, INC.,** *Third-Party Defendant.*	**CIVIL ACTION 6:20-cv-00980-ADA**

ANSWERING DECLARATION OF TODOR COOKLEV, PH.D.

I, Todor Cooklev, PhD, hereby declare as follows:

I. INTRODUCTION

1. I submit this answering declaration ("Declaration") in *WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Canon, Inc*., Civil Action No. 6:20-cv-00980-ADA (W. D. Tex.), on behalf of Plaintiff WSOU Investments, LLC d/b/a Brazos Licensing and Development (hereinafter, "WSOU" or "Plaintiff"), regarding certain terms of U.S. Patent No 7,054,346 ("the '346 patent") (attached herein as Ex. 1)[1], and in response to the August 23, 2021 Declaration of Dr. Zhi Ding In Support of Canon's Proposed Claim Constructions ("Ding Declaration" or "Ding Decl.")[2] that was served in support of Defendant Canon, Inc.'s ("Canon" or "Defendant") Opening Claim Construction Brief in this action[3] ("Op. Brief."). I will refer to the Plaintiff and Defendant together as "the Parties".

2. I understand that Plaintiff WSOU has filed patent infringement suits against Defendant Canon, Inc. ("Canon") asserting, among others, the '346 patent. I also understand that WSOU is asserting claims 1-4, 7, 9, 11-16, and 19 of the '346 patent. ("Asserted Claims"). I further understand that the Parties exchanged proposed constructions for claim terms of the '346 patent on August 2, 2021, and preliminary disclosure of extrinsic evidence on August 9, 2021. I further understand that pursuant to the Parties' stipulated claim construction schedule, Defendant Canon has served its Opening Claim Construction Brief on August 23, 2021. In support of its

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[1] Unless otherwise specified, all citations to "Ex. __" refer to exhibits to the September 15, 2021 Declaration of Jonathan K. Waldrop that I understand is being concurrently filed in support of WSOU's Responsive Claim Construction Brief.

[2] Ding Decl., C. A. No. 6:20-cv-00980-ADA, D.I. 52-1 (W. D. Tex. Aug. 23, 2021); C. A. No. 6:20-cv-981-ADA, D.I. 40-1 (W. D. Tex. Aug. 23, 2021).

[3] Canon's Op. Brief, C. A. No. 6:20-cv-00980-ADA, D.I. 52 (W. D. Tex. Aug. 23, 2021); C. A. No. 6:20-cv-981-ADA, D.I. 40 (W. D. Tex. Aug. 23, 2021).

claim construction positions in connection with the ’346 patent, Canon submitted the Declaration of Dr. Zhi Ding (“Ding Declaration”) along with its Opening Claim Construction Brief. Accordingly, I have been asked to review, evaluate, and respond to the Ding Declaration.

II. SCOPE OF WORK

3. I have been asked to explain what a person of ordinary skill in the art would have understood certain terms in the ’346 patent to mean in and around May 7, 2001 – the earliest effective filing date of the application of the ’346 patent.[4]

4. I have been also asked to evaluate and respond to the Ding Declaration.

5. An explanation of my opinions is set forth below.

6. To the extent I do not specifically opine on something raised in the Ding Declaration that does not mean I agree with the point or issue.

7. If asked, I am prepared to testify regarding the matters I discuss in this Declaration.

8. I based this Declaration on information currently available to me. I understand that further expert discovery will occur at a later stage in this case, including the submission of expert reports on the infringement and validity of the ’346 patent. I reserve the right to continue my investigation. I further reserve the right to expand, modify, update, and/or supplement my opinions in this Declaration regarding the meaning of the claims of the ’346 patent through any further expert reports and/or testimony that I may provide in this case. I further reserve the right to expand, modify, update, and/or supplement my opinions as additional information becomes available to

[4] I understand that while Canon has served arguments in connection with the meaning of certain terms as used in the claims of U.S. Patent No, 7,116,714 (“the ’714 patent”) asserted in Civil Action No. 6:20-cv-00981-ADA, Canon’s expert Dr. Ding has not proffered opinions in connection with the ’714 patent. To the extent Defendant Canon’s experts provide any further opinions regarding the claims of the ’714 patent after the date of this Declaration, I reserve the right to respond to those opinions and supplement my Declaration.

me, including in response to matters raised by the defendants and/or defendants' expert(s), or in view of relevant orders and findings by the Court.

9. I am over eighteen years of age and I would be competent to testify as to the matters set forth herein if I am called upon to do so.

10. This declaration addresses the following claim terms for the '346 patent:

Claim Term	Plaintiff's proposed construction	Defendant's proposed construction
"a time period T" / "[at least] a portion of the time period T"	Plain and ordinary meaning; or, if the Court deems a construction is necessary: "a period of time T" /"[at least] a portion of the time period T"	"T is a pre-set amount of time for one cycle of frequency hopping, which is no longer than the amount of time it would take to use each channel available for frequency hopping once," otherwise indefinite.
"a set of N frequencies"/ "a size of N/F frequencies" / "a set of F frequencies" / "a set of hopping frequencies" / "a hopping set" / "a hopping set to a size of N/F frequencies" / "a hopping set comprising N/F frequencies" / "where N is the total number of frequencies available for frequency hopping"	Plain and ordinary meaning	"N frequencies" / "a set of hopping frequencies" / "a hopping set" are "a preconfigured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T," otherwise indefinite. "a size of F frequencies" / "a set of F frequencies" / "a hopping set to a size of F frequencies" / "a hopping set comprising F frequencies" are "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period", otherwise indefinite
"at least one of the selected frequencies is prohibited from subsequent selection"	Plain and ordinary meaning; or, if the Court deems a construction is necessary:	"a frequency that has already been used during the time period T is prohibited from being re-used during the

Claim Term	Plaintiff's proposed construction	Defendant's proposed construction
	"at least one of the selected frequencies is not allowed to be subsequently selected"	remainder of the time period T solely because it has been previously used"
"pseudorandom[ly]"	Plain and ordinary meaning; or, if the Court deems a construction is necessary: "appears to be patternless"	"a selection generated by an algorithm that approximates a random selection by avoiding a regular pattern of selections when the algorithm is used repeatedly"

III. QUALIFICATIONS

11. I am currently professor of electrical and computer engineering at Purdue University in Fort Wayne, Indiana, where I have had several administrative and faculty appointments.

12. I received a Doctor of Philosophy (Ph.D.) degree in Electrical Engineering from Tokyo Institute of Technology in Tokyo, Japan in 1995.

13. I teach several courses related to the hardware and software architectures of wireless systems and wireless devices. My research interests include most aspects of modern wireless systems, including hardware/software architectures.

14. I have received research funding from the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the U.S. Air Force Research Laboratory, the Office of Naval Research, and a number of private companies, including major technology companies.

15. I have authored and co-authored more than 100 peer-reviewed articles. I am also a named inventor on 32 U.S. patents, most of which relate to the hardware or software aspects of communication systems. For part of this work in 2019, I was inducted into the Purdue Inventors Hall of Fame.

16. In addition to my academic experience, I have experience in technology and product development in the computer networking and data communications industry. My work has been in digital signal processing, software, and integrated circuit design for communication systems. In particular, I have worked on the development of the technology related to the field described in the ’346 patent.

17. I have contributed to the development of several major standards for communication systems and numerous amendments. I have participated in many meetings of standards committees. I have prepared, submitted, and presented documents relating to technical matters considered by these committees.

18. Starting in late 1998/early 1999, I was among the first contributors to the Bluetooth 1.0 standard. I also participated in the Bluetooth/IEEE group, which established the relationship between these entities and ultimately led to the establishment of the IEEE 802.15 Working Group. Later I was a Voting Member of the IEEE 802.15 Working Group.

19. Further, I have been a Voting Member of the IEEE 802.11 Working Group. I have been Chair or a Study Group within IEEE 802.11 and served in other leadership roles. For part of my work I received an award from IEEE Standards Association in 2012.

20. As part of my long record of service to IEEE, I served as Chairman of the IEEE Standards in Education Committee. In 2020, I was elected to serve on the Board of Governors of the IEEE Standards Association for one term beginning January 2021. The Board of Governors provides overall leadership of the IEEE Standards Association. Also, I am the Series Editor for Wireless and Radio Communications for the IEEE Communications Standards Magazine (which is the premier journal in the field of communication standards) and have held that position since 2017.

21. I am qualified by education and experience to testify as an expert with respect to subject matter in the fields of wireless communications, wireless communications protocols, wireless data transmission, wireless device hardware, data and signal processing hardware and software, and wireless device interoperability.

22. I have conducted research concerning frequency hopping technology. My research has concerned dynamic and adaptive frequency hopping schemes.

23. I have attached a current copy of my curriculum *vitae* as Appendix 1, which includes a list of my publications. My CV also includes a list of cases during at least the last five years in which I have signed a Protective Order, have testified as an expert either at a trial, hearing, or deposition, or have submitted statements/opinions.

IV. COMPENSATION

24. I am being compensated for my work in this case at my standard hourly rate for consulting services. My compensation is in no way tied to the outcome of these matters or to the content of this Declaration, any additional opinions I may submit in these matters.

V. MATERIALS CONSIDERED

25. I have considered the following materials in preparing the opinions set forth in this Declaration:

- the ’346 patent, including the abstract, specification, claims, and figures;
- relevant portions of the patent prosecution history of the ’346 patent in the United States Patent & Trademark Office (“the PTO”);
- U.S. Patent No. 4,654,859 (Kung)
- U.S. Patent No. 5,541,954 (“Emi”)
- U.S. Patent No. 5,377,221 (“Munday”)

- U.S. Patent No. 6,345,066 ("Haartsen")
- the extrinsic evidence identified by the Parties in their August 9, 2021 disclosures;
- Ding Declaration, and the exhibits therein; and
- Canon's Opening Claim Construction Brief (and the exhibits therein).

26. These materials would have been available to a person of skill in the art prior to May 7, 2001, the relevant priority date of the '346 patent and would have been relied upon and consulted by a person of skill in the art in the ordinary course of their work:

27. I have also relied on my knowledge, education, and professional expertise of over 20 years in the area of wireless communications, wireless communications protocols, wireless data transmission, wireless device hardware, data and signal processing hardware and software, and wireless device interoperability including frequency hopping.

VI. APPLICABLE LEGAL STANDARDS

28. For the purposes of this Declaration, counsel has instructed me to make the following assumptions:

a. Claim construction is solely a matter for the Court to decide and, in general, the ordinary meaning of the claim terms used in the patent to one of ordinary skill in the art is determined in the context of the patent's specification and the file history.

b. A "person of ordinary skill in the art" is a hypothetical person who is presumed to have known the relevant art at the time of the invention. Factors that may be considered in determining the level of ordinary skill in the art may include: (1) type of problems encountered in the art; (2) prior art solutions to those problems; (3) how quickly innovations are made; (4) sophistication of the technology; and (5) educational level of active workers in the field. In a given case, every factor may not be present, and one or more factors may predominate. A person of

ordinary skill in the art is a person of ordinary creativity. A person of ordinary skill in the art would have the capability of understanding the scientific principles applicable to the pertinent art.

c. Claims are construed from the perspective of a person of ordinary skill as of the effective filing date of the patent application. For the '346 patent, that date is May 7, 2001.

d. Persons of ordinary skill in the art are deemed to read the claims in the context of the entire patent, including the specification and prosecution history. In other words, the terms are not considered in a vacuum. In the context of claim construction, the specification has been called "the single best guide" to the meaning of the claim terms.

e. Claim terms should be given their ordinary and customary meaning within the context of the patent in which the terms are used, *i.e.*, the meaning that the term would have a person of ordinary skill in the art in question at the time of the invention in light of what the patent teaches.

f. The plain and ordinary meaning is determined from the language of the claims, the specification, and the prosecution history of the patent at issue.

g. In construing a claim term, one looks primarily to the intrinsic patent evidence, which includes the patent abstract, specification, claims, and figures, and its prosecution history.

h. Extrinsic evidence may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient.

i. The usual and customary meaning of a claim term can be altered by the patent applicant if they choose to act as their own "lexicographer" and clearly set forth in the patent a different meaning of a claim term.

j. The meaning of a claim term can also be altered during the patent examination process by a clear and unequivocal disclaims and disavowals by the patent applicant makes about

the meaning or scope of the term, and that such statements are recorded in the prosecution history of the patent application.

k. If a claim term is ambiguous or unclear, the term must be construed to determine how a person of ordinary skill in the art would have resolved in light of the rest of the patent specification, patent claims, and the application's prosecution history.

l. A claim is not indefinite, as long as it, having been read in light of the intrinsic evidence, informs one of skill in the art at the time of the invention about the scope of the invention with reasonable certainty.

m. It is improper to import limitations from embodiments in the specification.

n. It is also improper to import limitations from other parts of the claims thus rendering a claim term duplicative.

o. It is also improper to import additional or different language from other independent claims that would render such claims superfluous.

VII. THE PERSON OF ORDINARY SKILL IN THE ART

29. Throughout this Declaration, I refer to a person of ordinary skill in the art ("POSITA").

30. For the '346 patent, I have reviewed the definition of a POSITA offered by Dr. Ding in Paragraph 22 of his declaration.

31. Dr. Ding opines that a POSITA at the time of the invention of the '346 patent "would have had a Bachelor's degree in an accredited program of Electrical Engineering, Computer Engineering, or in a similar discipline, and have 3-4 years of practical work or research experience with specialization in the general field of wireless communications and networking.

More advanced degrees and/or training in a related discipline can compensate for shorter work experience." (Ding Decl. at ¶ 22).

32. For the '346 patent, I have been asked to assume the definition of a POSITA offered by Dr. Ding is correct for the purposes of my analysis in this Declaration. Without conducting any independent analysis myself of what definition of a POSITA would apply here, I have thus applied Dr. Ding's definition solely for the purposes of my opinions in this Declaration.

33. Under Dr. Ding's definition of a POSITA, I exceeded that level during the relevant time period. By May 2001, I had already earned by doctorate degree in Electrical Engineering, and gained six (6) years of practical and/or research experience with specialization in the general field of wireless communications and networking.

VIII. '346 PATENT BACKGROUND OF THE TECHNOLOGY

34. I have been asked to provide some background of the technology relevant to the '346 patent. This background is presented below.

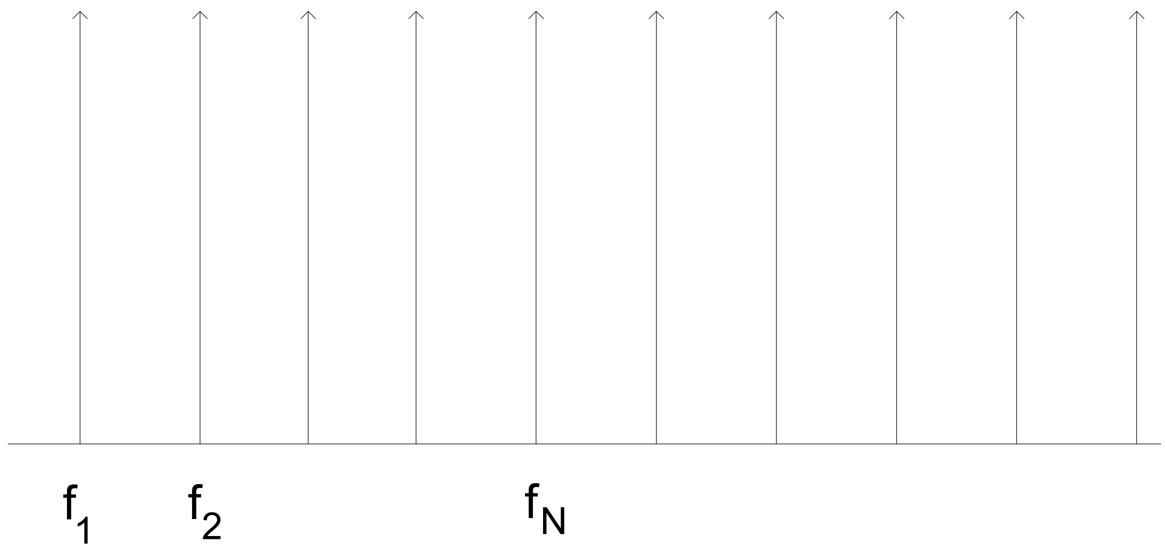
35. Wireless communication systems have a transmitter that transmits radio signals that occupy a frequency band and a wireless receiver that receives those signals.

36. Frequency hopping is a wireless communication method for transmitting radio signals in which the narrow frequency band used to communicate is not constant during communication but the carrier frequency changes among many different frequencies. In other words, the transmitter and receiver continually "hop" from one narrow frequency band to another.

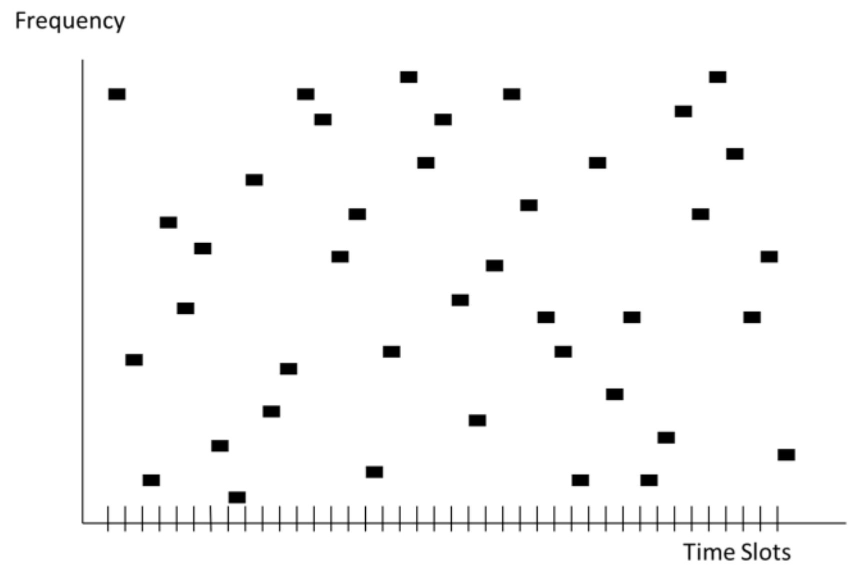
37. In Global System for Mobile Communication ("GSM"), frequency hopping can be used when the mobile station experiences high interference. When the base station activates frequency hopping, it assigns a set of radio frequency ("RF") channels or narrow frequency bands and a hopping algorithm.

38. A hopping algorithm informs the transmitter and the receiver how to determine the hopping frequencies.

39. A set of N frequencies over which to hop is illustrated in the figure below, which I prepared.



40. When frequency hopping is used between two devices, the devices first communicate using one frequency, then determine the next frequency, tune to the next frequency, and the process repeats, as illustrated in the figure below. The Y-axis depicts the available frequency channels. And, the X-axis is divided into various time slots. As shown in the illustration, the signal is not transmitted through one single frequency channel but hops between the available channels.



IX. THE ’346 PATENT

41. I have reviewed Dr. Ding’s statements regarding the disclosure in the ’346 patent and its prosecution history. Dr. Ding provides various characterizations of the patent disclosure. (Ding Decl. at ¶¶ 28-40). In light of my own review of the ’346 patent’s specification and prosecution history, I disagree with Dr. Ding.

A. BACKGROUND OF THE INVENTION

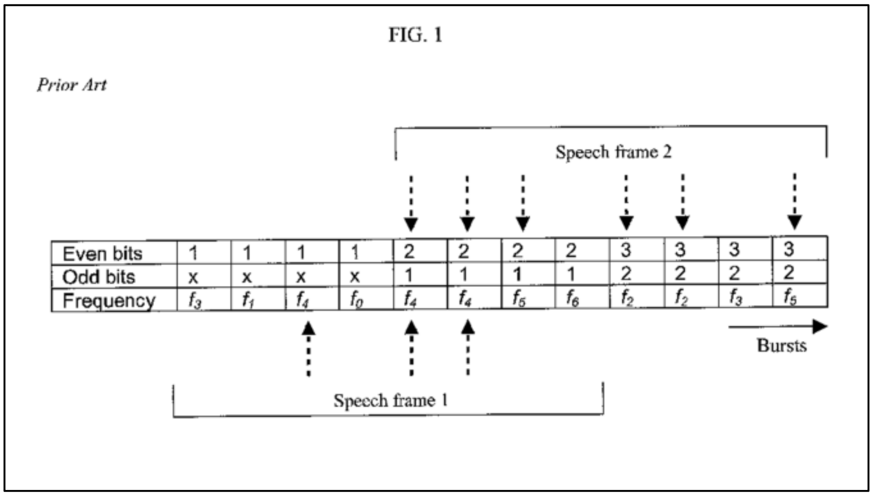
42. The ’346 patent relates to wireless communication systems, particularly frequency hopping. As a general matter, by May 2001, a POSITA would have been familiar with the principle of frequency hopping. However, the specification of the ’346 patent identifies technical problems in the prior art. By May 2001, as the ’346 patent explains, a number of wireless communication systems, such as GSM used frequency hopping methods for transmitting signals. (Ex. 1 (’346 patent) at 1:18-22). The GSM system was developed at the time, and described in a number of documents, such as 3GPP TS 45.002, “3rd Generation Partnership Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)”. (*Id*. at 1:41-45).

43. By May 2001, frequency hopping that is carried out burst by burst was known "to mitigate the effects of fading and interference." (*Id*. at 1:32-33). It was recognized that frequency hopping methods were meant to achieve the following benefits: fading diversity, interferer diversity, and interference averaging. (*Id*. at 1:34-36).

44. The '346 patent states that by May 2001, the frequency hopping methods that were used in wireless communication systems were not able to completely achieve the intended benefits of fading and interferer diversity. (*Id*. at 1:37:39). For example, cyclic frequency hopping was able to achieve full fading diversity, albeit in certain circumstances, such as when "the number of frequencies is greater than the number of bursts over which a speech frame is interleaved and the frequencies are sufficiently separated from each other." (*Id*. at 1:45-53). However, by May 2001, it was recognized that cyclic frequency hopping methods were unable to provide the benefits of interferer diversity and interference averaging. (*Id*. at 1:53-54).

45. The specification further explained that pseudorandom frequency hopping methods were able to provide interferer diversity and long-term interference averaging but were unable to guarantee fading diversity since there were frequency repetitions within the interleaving depth. (*Id*. at 1:55-59).

46. If a large amount of spectrum is used, frequency repetitions are not common. However, there are limited spectrum scenarios, where frequency repetitions always occur. (*Id*. at 1:60-2:15). An example of the frequency repetition issue is described in FIG. 1 of the '346 patent, reproduced below.



47. Fig. 1 of the ’346 patent describes a situation assuming only eight available frequencies, f_0 to f_7. Fig. 1 shows that in Speech frame 1, frequency f_4 is repeated 3 times. Consequently, speech frame 1 is able to use only 6 of 8 unique independent fading states. Similarly, in Speech frame 2, frequencies f_2, f_4, and f_5 are repeated twice each, and thus Speech frame 2 is only able to use 5 of 8 independent fading states. (*Id*. at 1:67-2:15).

48. Thus, the ’346 patent further describes that:

> [T]he GSM pseudo-random frequency hopping algorithm does not maximize the number of unique frequencies (or independent fading states) in this case. This has consequences for low mobility users where the fading tends to be strongly correlated for time duration in excess of the interleaving depth of a speech frame. In this case, users may hop to the same frequency multiple times, experiencing similar channel fading conditions each time. With typical channel coding schemes employed for speech traffic channels and control signaling channels, increased correlation within the interleaving depth can lead to degradation in error performance.

(*Id*. at 2:15-26).

B. THE INVENTION IN THE ’346 PATENT

49. In his declaration, Dr. Ding provides his own interpretation of the solution that the ’346 patent provides. (Ding Decl. at ¶¶ 34-40). I disagree with many of his characterizations.

50. In my opinion, a POSITA reading the '346 patent would understand that the invention claims a technical solution to the problems in the prior art through an "enhanced frequency hopping system," which uses pseudorandom frequency hopping to "maximize[] the number of unique frequencies" used in the hopping to improve fading diversity. (Ex. 1 ('346 patent) at Title; Abstract; 2:31-48; 7:27-30). The specification explains that the "maximiz[ation]" of unique frequencies is achieved by "constraining" the hopping frequency sequences "in order to ***reduce, minimize, repeated*** frequencies over a time period T." (*Id*. at 3:38-40; 7:20-24 (emphasis added)). The specification also explains frequency hopping algorithm applies across "consecutive bursts across ***multiple frames***," permitting overall improvement of fading diversity. (*Id*. at 6:57-61 (emphasis added)).

51. The '346 patent further describes the invention as a wireless endpoint that performs "pseudorandom selection of a frequency from a hopping set of N frequencies such that over at least ***a portion of*** the time period T, the frequency selection is ***constrained*** to less than the N frequencies." (*Id*. at Abstract, 2:31-36) (emphasis added)). Similarly, the Summary of the Invention section of the '346 patent further describes that "over at least ***a portion*** of the time period T the choice of frequencies to select from within the hopping set is ***constrained*** as a function of previously selected frequencies." (*Id*. at 2:39-44 (emphasis added)). That section further states "[i]n particular, prior selected frequencies are ***temporarily prohibited*** from being selected again from the hopping set. Thus, ***repetition*** of frequencies over the time period T is ***reduced***." (*Id*. at 2:44-47 (emphasis added)).

52. In my opinion, in light of the specification, a POSITA would have understood that the "constrain[ing]" is in the form of "***reducing***" or "***minimizing***" "***repeated*** frequencies", but not that the scope of invention is limited to only the instance where no frequency is repeated over the

entirety of "time period T." In fact, the specification supports a frequency hopping algorithm where a frequency could be used more than once over "time period T." For example, the specification provides an illustrative example where the total number of frequencies, N, is 4, "across two consecutive sets of four bursts, no frequency would be repeated three or more times." (*Id*. at 3:42-46). In that example, the algorithm achieves only two frequency repeats over two consecutive sets of four bursts. In my opinion, in light of the specification, a POSITA would also have understood that the "constrain[ing]" in the form of a "***temporary prohibition***" of frequency selection, *i.e.*, that is performed only over "a ***portion*** of the time period T," not the entirety of the time period T. In that way, a POSITA would have understood that the constrained hopping algorithm maximizes the number of unique frequencies, and achieves the goal of increasing fading diversity overall.

53. The specification describes illustrative examples, one in which the total number of frequencies available to hop, *i.e.*, N is 4 (the '346 patent, 3:42-46), and another where N is 8 (*id*. at 3:46-52; 5:21-6:42; Fig. 3; Fig. 6). I have been advised that these illustrative examples are merely example embodiments in the patent. I have also been advised that it is improper to limit the scope of a patented invention to any particular embodiment(s). Indeed, the '346 patent also states "[i]t should be noted that although the negative effects of frequency repetitions decrease for GSM hopping sets with larger values of N, *e.g.*, N=12, the inventive concept ***still provides improvement***." (*Id*. at 3:52-56 (emphasis added)).

54. As discussed above, Dr. Ding's declaration includes numerous characterizations of the '346 patent with which I disagree. For example, Dr. Ding contends that "the '346 patent says its solution to what it describes as a problem in GSM is an algorithm that ***prevents*** a frequency from being repeated in ***a*** channel cycle." (*Id*. at ¶ 34 (emphasis added); *see also id*. at ¶ 36). I

disagree. As discussed above, the '346 patent discusses the invention(s) as applying over a least a portion of the time period T. (*See supra* at ¶¶ 51-52). In addition, the '346 patent describes the invention in terms of a time period T, and does not limit that time period to any particular "cycle" or "channel cycle". One or more embodiments of the claimed invention include "shift[ing] the hopping set in a *cyclical* direction." (Ex. 1 ('346 patent) at claims 6, 18 (emphasis added)). In light of the specification, a POSITA would not have understood "shift[ing] the hopping set in a *cyclical* direction," to mean a "cyclic" time period."

55. Dr. Ding further contends that the Fig. 3 example also supports his opinion that the invention requires that a previously selected frequency cannot be reselected for use during the remainder of time period T solely because it was previously selected. (Ding Decl. at ¶ 36). I disagree. There is nothing in the patent's description of the Fig. 3 example that could lead a POSITA to that conclusion. In my opinion, the algorithm in the '346 patent prevents reselection over only at least "a ***portion*** of the time period T." (*See supra* at ¶¶ 51-52).

56. I also disagree with Dr. Ding that the '346 patent guarantees that are "no repeats". As described, repeats are allowed, just that they are at least reduced in number. (*See supra* at ¶¶ 51-52; *see also* Ex. 1 ('346 patent) at 2:45-48) ("prior selected frequencies are ***temporarily*** prohibited from being selected again . . .Thus, repetition of frequencies over the time period T is reduced"). There is nothing in the '346 patent that limits the invention to cases only where there is no repetition of frequencies. Reduced repetition of frequencies according to the '346 patent's algorithm can nonetheless achieve improvement in fading diversity over the prior art pseudorandom frequency hopping algorithms.

57. Dr. Ding also asserts that the '346 patent's algorithm is limited in which "each of the available frequencies is selected ***no more than once***." (Ding Decl. at ¶ 39 (emphasis added)).

I disagree. The paragraph that Dr. Ding cites does not support his opinion. (Ex. 1 ('346 patent) at 3:38-46). There is nothing in this paragraph about "each of the available frequencies being selected no more than once." Contrary to Dr. Ding's opinion, this paragraph states that "hopping frequency sequences are constrained in order to reduce, or minimize, repeated frequencies over a time period T". (*Id.*) That contradicts Dr. Ding's proposal, let alone suggest it. Consequently, I disagree that the algorithm is so restricted as Dr. Ding suggests.

58. Dr. Ding further opines that "[t]o provide the advantages of the purported '346 patent invention, the time period T must not be longer than the time period needed to select each frequency exactly once." (Ding Decl. at ¶ 39). I disagree. As further explained below, there is simply no support in the patent to set an upper bound to the time period T that Dr. Ding seeks to impose. The patent specification makes clear that "over at least a portion of the time period T, the frequency selection is constrained," (Ex. 1 ('346 patent) at Abstract, 2:42-44), which directly contradicts Dr. Ding.

X. THE '346 PATENT PROSECUTION HISTORY

59. I have reviewed the '346 patent prosecution history and Dr. Ding's characterization of the same. (Ding Decl. at ¶¶ 41-46). I disagree with his characterizations as further explained below.

60. I provide below a chronological description of the relevant prosecution history of the '346 patent and my responses to Dr. Ding's mischaracterizations.

A. AUGUST 16, 2004 AMENDMENT AND RESPONSE

61. On May 7, 2001, the applicant filed U.S. Patent Application No. 09/850,124, which issued the '346 patent on May 30, 2006. (Ex. 1 ('346 patent), face of the patent). The applicant originally filed a total of 27 claims.

62. Subsequently, the first office action was issued on May 20, 2004. (Ex. 5 May 20, 2004 Office Action ("May 2004 Office Action"). In that action, the Examiner contended that original claims 1, 3, 5, 6, 8-10, 12-17, 19, 21, 22, and 24-26 were purportedly anticipated by either U.S. Patent No. 4,654,859 to Kung ("Kung") (Ex. 6) or U.S. Patent No. 5,541,954 to Emi ("Emi") (Ex. 7). The Examiner also contended that original claims 2, 4, 7, 11, 18, 20, 23, and 27 were allegedly obvious over Kung. (*See* Ex. 5 (May 2004 Office Action)).

63. On August 16, 2004, the applicant filed a response and amended claims 1, 3, 5, 6, 8, 10, 15, 17, 19, 21, 22, 24, and 26 to include the "pseudorandom[ly]" limitation to these claims while cancelling dependent claims 2, 4, 7, 11, 18, 20, 23, and 27. (Ex. 8 (August 16, 2004 Amendment and Response ("August 2004 Response")). In that response, the applicant provided clarifications regarding Kung and Emi references.

64. With respect to Kung, the applicant explained that "Kung selects a frequency by cycling through an ordered frequency set in a predetermined fashion. In contrast, the present invention pseudorandomly selects a hopping frequency." (Ex. 8 (August 2004 Response) at p. 11)).

65. With respect to Emi, the applicant noted that "Emi appears to disclose a frequency hopping scheme where a receiver counts errors it has received on each given frequency. If a total error count exceeds some metric, then the received frequency will be deemed unusable and an alternative, unused frequency will be substituted in its place." (*Id.*). The applicant merely clarified that "[o]ne of ordinary skill in the art, on reading Emi would not equate Emi's substitution of a new frequency [based on error counts] with pseudorandom frequency hopping selection." (*Id.*).

66. In the August 2004 Response, the applicant also clarified that the claims do not require "a predetermined pseudorandom pattern," and that the Examiner's contention regarding that feature was without evidentiary support and thus improper. (*Id*. at pp. 11-12).

B. APRIL 5, 2005 REQUEST FOR RECONSIDERATION

67. In the subsequent office action issued on January 7, 2005, the Examiner, *inter alia*, removed the rejections over Kung and Emi. (Ex. 9 (January 7, 2005 Office Action ("January 2005 Office Action")) at p. 2). The Examiner also allowed then pending claims 8-10, 12-14, and 24-26. (*Id.* at p. 6).

68. However, the Examiner contended that claims 1, 3, 15-17, and 19 are purportedly anticipated by U.S. Patent No. 5,377,221 to Munday ("Munday") (Ex. 10) and claims 1, 5, 6, 21, and 22 are purportedly anticipated by U.S. Patent No. 6,345,066 to Haartsen ("Haartsen") (Ex. 11). (Ex. 9 (January 2005 Office Action) at pp. 2-6).

69. On April 5, 2005, the applicant filed a Request for Reconsideration. (Ex. 12 (April 5, 2005 Request for Reconsideration ("April 2005 Request"))). There, the applicant amended then pending claims 1, 5, 6, 8, 10, 15, 17, 19, 21, 22, 24, and 26 to include one or more following elements: (i) "such that at least one of the selected frequencies is prohibited from subsequent selection in at least a portion of the time period T"; (ii) "where N is the total number of frequencies available for frequency hopping"; and/or (iii) "where F is the number of frequencies in a hopping state, H over which a wireless endpoint is constrained to hop." (*Id.* at pp. 2-10).

70. The applicant clarified the following with respect to Munday and Haartsen:

> [N]either Munday nor Haartsen, taken separately or in combination, discloses or suggests such a prohibition on frequency selection. Instead, it appears that after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition. Said another way, neither Munday nor Haartsen is prohibited from re-selecting a frequency from a set of allowable

> frequencies, that has already been selected during a time period, T, as in the claims of the present invention.

(*Id*. at pp. 11-12).[5]

C. DECEMBER 15, 2005 NOTICE OF ALLOWABILITY

71. On January 13, 2006, in response to applicant's clarifications in its April 5, 2005 Response, the rejections over Munday and Haartsen were withdrawn and the claims were allowed. (Ex. 13 (December 15, 2005 Notice of Allowability mailed January 13, 2006 ("Notice of Allowability"))).

72. The Examiner explained the reasons for allowance:

> None of the prior art teaches or suggests a frequency hopping method as the current application. In specific, pseudorandomly selecting frequency from a set N (total number of frequencies available) frequencies, where prior selected frequencies are prohibited from being selected again from the hopping set. Thus, repetition of frequency over time period T is reduced.

(Ex. 13 (Notice of Allowability) at p. 1).

XI. <u>THE '346 PATENT'S DISPUTED TERMS</u>

A. THE "TIME PERIOD T" TERMS (ALL ASSERTED CLAIMS)

Claim Term	WSOU's Proposed Construction	Canon's Proposed Construction
"a time period T"/ "[at least] a portion of the time period T"	Plain and ordinary meaning; or, if the Court deems a construction is necessary: "a period of time T"/ "[at least] a portion of the period of time T"	"T is a pre-set amount of time for one cycle of frequency hopping, which is no greater than the amount of time it would take to use each channel available for frequency hopping once," otherwise indefinite.

[5] On April 5, 2005, along with the Request for Reconsideration, the applicant also filed an appeal brief on April 29, 2005 (Ex. 14 (April 29, 2005 Appeal Brief ("April 2005 Appeal"))). The applicant repeated the same clarifications with regard to Munday and Haartsen.

1. The "Time Period T" Terms Should be Given Their Plain and Ordinary Meaning

73. As explained below, in my opinion, these "time period T" terms need no construction; they should be given their plain and ordinary meaning. In my opinion, the plain and ordinary meaning of the terms "a time period T"/ "[at least] a portion of the time period T" is "a period of time T"/ "[at least] a portion of the period of time T", respectively.

74. The intrinsic record supports that these terms have their plain and ordinary meaning. For example, the claim language is clear that "time period T" refers to a "period of time" defined by "T", and "at least a portion of the time period T" refers to a "portion" or part of that period of time, not the entirety.

75. Additionally, the "time period T" terms are used throughout the '346 patent specification in the same way. (Ex. 1 ('346 patent) at Abstract; 2:31-48; 3:38-56; all claims). For example, the specification refers to "time period T" as the period of time over which a device "transmits signals using frequency hopping." (*Id.*) In light of the specification, a POSITA would understand that the "time period T" in the context of the claims is the period of time over which the device transmits signals using the frequency hopping method according to the invention. (*Id.*)

76. A POSITA also would understand the specification describes an algorithm that performs pseudorandom frequency hopping in which "[o]ver a ***time period T***, the wireless endpoint performs pseudo-random selection of a frequency from a hopping set of N frequencies such that over ***at least a portion of the time period T***, the frequency selection is constrained to less than the N frequencies." (Ex. 1 ('346 patent) at Abstract (emphasis added)). The Summary of the Invention section of the '346 patent further provides:

> Over ***a time period T***, the wireless endpoint performs pseudo-random selection of a frequency from a hopping set such that over ***at least a portion of the time period T*** the choice of frequencies to select from within the hopping set is constrained as a function of

> previously selected frequencies. In particular, prior selected frequencies are ***temporarily*** prohibited from being selected again from the hopping set. Thus, repetition of frequencies over ***the time period T*** is reduced.

(*Id*. at 2:39-48 (emphasis added)).

77. The Detailed Description Section of the '346 patent further provides: "In accordance with the invention, hopping frequency sequences are constrained in order to reduce, or minimize, repeated frequencies ***over a time period T***." (*Id*. at 3:38-40 (emphasis added)). By May 2001 and even to the present, a POSITA would have understood "time period T" to be a variable commonly used in computer programs and algorithms in electrical and computer engineering. Indeed, Dr. Ding does not dispute that the "T" term is a variable. (Ding Decl. at ¶ 48). By May 2001, the meaning of "time period T" terms would have been well-understood by a POSITA and used routinely in well-known textbooks in electrical and computer engineering. A POSITA would have known that algorithms are written using variables. Indeed, algorithms are generally written using variables. By May 2001 and to date, a POSITA would understand that these variables are given specific values when the algorithms are executed.

2. There is No Support for Canon's Proposed Construction.

78. Dr. Ding argues that "[o]n its own, the term 'time period T' would not have a definite plain and ordinary meaning to a POSITA at any time, including in 2001," because it is "an undefined variable." (Ding Decl. at ¶ 47). Dr. Ding contends that, as a result, a POSITA would have purportedly understood the meaning of "time period T" to mean "a pre-set amount of time for one cycle of frequency hopping, which is no greater than the amount of time it would take to use each channel available for frequency hopping once." (*Id*. ¶ 50). I disagree with the proposed construction because nothing in the claims or specification supports it, and it is inconsistent with the terms' definite plain and ordinary meaning.

79. For example, I do not see any support for limiting "T" in the manner that Dr. Ding seeks: (i) to "one cycle of frequency hopping"; and (ii) to "no greater than the amount of time it would take to use each channel available for frequency hopping once." (Ding Decl. at ¶¶ 50-53). Such limitations are not expressly stated or even suggested in the claims or the specification. In fact, the proposed limitations are contrary to the plain language of the claims and the specification. For example, the claims require that "at least one of the selected frequencies is prohibited from subsequent selection *over some portion* of the time period T", but do not require – as Dr. Ding contends – that the *each* previously selected frequency is prohibited from being repeated over the *entire* time period T.

80. Furthermore, as explained above, the specification makes clear that the pseudorandom frequency hopping algorithm according to the invention "maximizes" the number of unique frequencies by "constraining" the hopping sequences in the form of "reducing" or "minimizing," not "prohibiting" or eliminating repeated frequencies "across multiple frames" over "time period T". (*Supra* at ¶ 50). Additionally, as explained above, the specification also makes clear that "constraining" the hopping sequences in the form of a "temporary prohibition" of frequency selection is performed only over "a portion of the time period T," not the entirety of that period. (*See supra* at ¶¶ 51-52). In that manner, the pseudorandom frequency hopping algorithm maximizes the number of unique frequencies and achieves the goal of increasing fading diversity overall. As discussed above, the '346 patent discusses the invention(s) as a reduction of repeating frequencies over a least a portion of time period T. In addition, the '346 patent describes the invention in terms of a time period T, and does not limit that time period to any particular "cycle". (*See supra* at ¶¶ 51-52, 54).

81. Similarly, as further explained above, there is no support in the patent to limit T to "the amount of time it takes a frequency hopping system to ***use each available channel*** for frequency hopping ***once***," as Dr. Ding suggests. (*See supra* at ¶¶ 50-52, 57, 58). In relevant part, that section of the specification provides "[over] a time period T, . . . [i]n particular, prior selected frequencies are ***temporarily*** prohibited from being selected again from the hopping set." (Ex. 1 ('346 patent) at 2:45-48 (emphasis added)). As explained above, in my opinion, in light of the specification, a POSITA would have understood that the prohibition is only ***temporary***, over only "a portion of the time period T," and not over the entirety of the time period T.

82. As explained above, contrary to Dr. Ding's view, the pseudorandom frequency hopping algorithm achieves the goal of increasing fading diversity overall, not only by "prohibiting" frequency repeats temporarily over a "***portion*** of a period of time T," but also by "***reducing***" the number of frequency repeats across multiple frames over the entirety of the period of time T. (*See supra* at ¶¶ 50-52; *see, e.g*., Ex. 1 ('346 patent) at 2:47-48 ("repetition of frequencies is reduced.")).

83. By "one cycle of frequency hopping," Dr. Ding may be referring to a set of certain number of bursts or one speech frame. (*See, e.g*., Ex. 1 ('346 patent) at Fig. 1, 3; 3:38-46). Even then his contention fails. As explained above, in my opinion, the specification expressly does not support limiting "T" to "one cycle," or to "one set of a certain number of frequency bursts," to cover only "the amount of time it would take to use each available channel for frequency hopping once." (*See supra* at ¶¶ 51, 52, 54, 80). For example, the '346 patent specification states "[i]n accordance with the invention, hopping frequency sequences are ***constrained*** in order to ***reduce, or minimize, repeated frequencies over a time period T***." (The '346 patent, 3:38-40 (emphasis added)). In my opinion, a POSITA would understand that over

the period of time T, the claimed frequency hopping method is "constrained" to "reduce, or minimize repeated frequencies." A POSITA would ***not*** understand this to mean repetition is "***prevented***" over the "time period T."

84. In its Opening Brief, Canon argues that during the patent prosecution the applicant "consistently limited the claims to a specific algorithm in which a frequency cannot be repeated during one time cycle, e.g., the amount of time it takes a frequency hopping system to use each channel available for frequency hopping once." (Op. Brief at 13). I disagree. I reviewed the '346 patent's prosecution history and I cannot find any support for Canon's contention. To the contrary, Dr. Ding's and Canon's proposed limitations are contradicted by the statements in the prosecution history. As I explained above, in the April 2005 Request, the applicant amended certain claims to require "at least one of the selected frequencies is prohibited from subsequent selection in at least a ***portion*** of the time period T." (*See supra* at ¶¶ 69, 70; Ex. 12 (April 2005 Request)). In addition, the applicants explained that the claims include "a feature of pseudorandomly selecting a frequency or frequencies from a set of frequencies that has been constrained, reduced, or limited 'such that at least one of the selected frequencies is prohibited from subsequent selection in at least ***a portion of [a] time period T***." (*Id.* at p. 11 (emphasis added)). The applicants further stated that "that neither Munday nor Haartsen, taken separately or in combination, discloses or suggests such a prohibition on frequency selection." *Id.* The applicants made similar argument in their appeal. In fact, the Notice of Allowability made clear that the invention over the prior art was that the "repetition of frequency over time period T is reduced." A POSITA would understand that the repetition need not be eliminated over the entire time period T. (Ex. 13 (Notice of Allowability) at p. 2). The examiner allowed the claims because none of the prior art taught the claimed

frequency hopping method such that "repetition of frequency over time period T is ***reduced***." (*See supra* at ¶¶ 71, 72).

3. The "Time Period T" Terms Are Not Indefinite

85. Dr. Ding further asserts that a POSITA purportedly would not have understood "the time period T to be independent of the claimed frequency hopping algorithm." (Ding Decl. at ¶ 49). Dr. Ding opines that a POSITA purportedly would also not have understood "these claims to allow the time period T to cover ***any*** arbitrary time period that the patent owner might, after the fact, choose for T." (Ding Decl. at ¶ 49 (emphasis in original)). Dr. Ding further asserts that "[i]f the patent owner were to attempt to claim that the period T could be ***any*** unlimited time period, a POSITA would not have known how to evaluate an algorithm to determine whether it fits within the scope of the claim or not." (*Id*. (emphasis in original)). I have reviewed Canon's Opening Claim Construction Brief. I understand that Canon relies upon Dr. Ding's assertions in paragraph 49 of his declaration to support its contention that the "time period T" terms are indefinite. I disagree.

86. The "time period T" terms are not "undefined" as Dr. Ding asserts. I also do not agree that there is any need for the '346 patent to limit the scope of the "time period T" to only specific values for a POSITA to be able to implement the pseudorandom frequency hopping algorithm according to the claims. Dr. Ding appears to be reading the time variable out of context here. The "time period T" is the time period over which the device is using frequency hopping, and a POSITA would understand that based on the claims and specification.

87. For example, the specification provides examples of wireless communication systems that use frequency hopping that can be used to implement the claimed invention. (*See, e.g.*, Ex. 1 ('346 patent) at 3:3-12) (listing GSM; 3GPP TS 45.002, 3rd Generation Partnership

Project; Technical Specification Group GERAN; Digital Cellular telecommunications System (Phase 2+); Multiplexing and Multiple Access on the Radio Path (Release 4)). The specification also provides a detailed description of the claimed pseudo-random frequency hopping algorithm over which the "period of time T" applies. (*Id*. at 3:38-56).

88. The '346 patent specification further provides guidance on the protocols to use to implement the frequency hopping algorithm according to the invention:

> The following should be noted with respect to protocol aspects. When a user enters the system (e.g. at the start of a voice call), the wireless endpoint must know the hopping state, H, the number of currently allowable frequencies, F, and the range of F defined by F_{min} and F_{max} where $0 \leqq F_{min} < F_{max} \leqq F$. F_{min} and F_{max} are assumed to be provided during call setup. The network can provide H and F to a wireless endpoint (e.g., a user terminal) in any number of ways, such as:
>
> > 1) These parameters can be provided during call setup signaling from another wireless endpoint along with an associated timestamp by suitable modification of messages used in existing call setup protocols. Since the algorithm to reconstruct the time evolution of H and F are known, either wireless endpoint can then determine the state information at the current time (effectively providing information on A, etc.); or
> >
> > 2) Alternatively, state information can be autonomously derived at a wireless endpoint by refreshing the state information at pre-determined time instants. For example, the state can be refreshed (i.e., $H=\{H_0, H_1, \ldots, H_{N-1}\}$, $F=F_{max}$) at predetermined time instants. The wireless endpoint can then reconstruct the time evolution of H and F from the previous refresh instant to the current time.

(*Id*. at 6:62-7:19).

89. Indeed, Dr. Ding describes a frequency hopping algorithm using a time period T term without defining that term further in an article published in 2007. (*See* Ling Q., Li T., and Ding Z., "A Novel Concept: Message Driven Frequency Hopping (MDFH)," 2007 IEEE International Conference on Communications, Glasgow, Scotland, 24-28 June 2007, pp. 5496-

5501, ("Ding 2007") Ex. 15.) In that article, Dr. Ding describes a message-driven frequency hopping algorithm. As part of that algorithm, he uses a number of different variables proportional to time, without specifying any lower and upper bounds. (*See* Ex. 15 (Ding 2007) at p. 5498 ("Let T_s and T_h denote the symbol [time] period and the hop duration, respectively. T_s/T_h, denoted by N_h, represents the number of hops per symbol, and is assumed to be an integer larger or equal to 1.")). There is no upper bound on the number of symbol periods for which Dr. Ding's algorithm applies.

90. In my opinion, given the above-cited disclosure, in light of the specification, a POSITA would have understood that "a period of time T" is the time period for which the system is using frequency hopping, and given the guidance in the specification, would have been able to derive the scope for time period T in the context of the claims.

B. THE HOPPING SETS OF "N" AND "F" FREQUENCIES (ALL ASSERTED CLAIMS)

Claim Term	WSOU's Proposed Construction	Canon's Proposed Construction
"a set of N frequencies"/ "a size of N/F frequencies" / "a set of F frequencies" / "a set of hopping frequencies" / "a hopping set" / "a hopping set to a size of N/F frequencies" / "a hopping set comprising N/F frequencies" / "where N is the total number of frequencies available for frequency hopping"	Plain and ordinary meaning	"N frequencies" / "a set of hopping frequencies" / "a hopping set" are "a pre-configured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T," otherwise indefinite. "a size of F frequencies" / "a set of F frequencies" / "a hopping set to a size of F frequencies" / "a hopping set comprising F frequencies" are "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period", otherwise indefinite

1. The "N/F Frequency" Terms Should be Given Their Plain and Ordinary Meaning.

91. In my opinion, "N/F Frequency" Terms should be given their plain and ordinary meaning because they are well-understood defined variables commonly used in the frequency hopping algorithms. The intrinsic record is consistent with plain meaning of these terms. The term "N" is clearly defined in the claim language itself as "the total number of frequencies available for frequency hopping." (Ex. 1 ('346 patent) at claims 1, 4, 5, 7, 13, 16, 17, and 19). The specification further provides that "N is the total number of frequencies available to hop over." (*Id*. at 3:61-62). Like the "N" term, the term "F" is also clearly defined in the claim language itself as "the number of frequencies in a hopping state H." (*Id*. at claims 3, 5, 15, and 17). The specification further provides that "F is ≦N and is the number of frequencies in H" and F is "the number of currently allowable frequencies."

92. Furthermore, like the "time period T" terms, by May 2001, a POSITA would have understood the "N/F Frequency" terms to be a variable commonly used in frequency hopping algorithms. Dr. Ding does not dispute these terms are variables. (Ding Decl. at ¶ 57). Like any computer code variables, by May 2001 and to date, a POSITA would understand that these variables are given specific values when the algorithms are executed.

93. Indeed, in Ding 2007, Dr. Ding himself uses a similar "N" frequency term without providing specific values other than the code itself and one illustrative example setting its value to 64. (*See, e.g.*, Ex. 15 (Ding 2007) at 5498). This demonstrates the common use of these terms in the field of frequency hopping algorithms. These terms were similarly common in the field as of May 2001.

2. Dr. Ding's Proposed Construction Introduces Language Already Covered In Other Parts of the Asserted Claims.

94. Dr. Ding opines that a POSITA would have understood that the "N" Frequency terms are purportedly limited to "a pre-configured number of distinct hopping frequencies to which the hopping constraining algorithm is applied and which must not be selected more than once over the time period T," and similarly, the "F" Frequency terms are purportedly limited to "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period." (Ding Decl. at ¶ 59).

95. In support, Dr. Ding contends that "N" and "F" must be so construed because the patent purportedly limits the prohibition on frequency repeats "during ***one*** time period T, e.g., the amount of time it takes a frequency hopping system to ***use each available channel*** for frequency hopping ***once***." (*Id*. at ¶ 60 (emphasis added)). I disagree for the same reasons above for why the "time period T" terms cannot be limited to one cycle or to each available channel to be used for frequency hopping only once. (*See supra* at ¶¶ 50-52, 78-83).

96. The asserted claims state that "at least one of the selected frequencies is prohibited from subsequent selection *over some portion* of the time period T", but do not require that *each* previously selected frequency is prohibited from being repeated over the *entire* time period T. Further, Dr. Ding and Canon's proposed limitations to the "N" and "F" would render the phrase "over some portion of the time period T" meaningless.

97. Similarly, the specification also contradicts Dr. Ding's proposed limitations to "N" and "F" frequency terms. For example, the specification refers to restricting frequencies over some "portion of the time period T" but *not* the entire time period T. (*See, e.g.*, Ex. 1 ('346 patent) at Abstract, 2:31-36, 2:45-48) ("prior selected frequencies are *temporarily* prohibited from being selected again from the hopping set"); *see also supra* at ¶¶ 50-52). The specification makes clear

that the purpose of that is so "repetition of frequencies over the time period T is *reduced*" – not eliminated altogether from being re-used during time period T. (*See id.* at 2:45-48 (emphasis added)).

98. Dr. Ding also relies on the '346 patent's disclosure of one of the problems in the prior art specifically that prior art pseudorandom frequency hopping systems did not "***guarantee fading diversity (i.e., no frequency repetitions) within the interleaving depth*** of a speech frame." (*Id.*) (citing the '346 patent at 1:55-59)). Dr. Ding contends that setting the proposed limitations on "N" and "F" are "necessary to achieve the 'ideal,' 'fully realized' version of frequency hopping claimed in the '346 patent." I disagree in part for the same reasons that the "time period T" terms cannot be limited to one cycle. (*See supra* at ¶¶ 50-52, 78-83).

99. Further, limiting "N" to those frequencies "which must not be selected more than once over the time period T," is improper for the same reasons described above for why the "time period T" terms cannot be limited in the manner that Dr. Ding imposes. (*See supra* at ¶¶ 57, 58, 78-82). The same reasons apply to why limiting "F" to "for a time period T, the number of remaining frequencies available for frequency hopping that have not been previously selected during that time period" is also incorrect. As explained above, in my opinion, a POSITA would understand that there may be repeats within the time period T, just that they are minimized in way that they are prevented only in a portion of that time. Additionally, in my opinion, a POSITA would understand a "portion of a period of time" would refer to only a part of the period of time, not the entirety of that time period.

100. Additionally, for the "F" terms, Canon's proposed construction renders superfluous the claim limitation "such that at least one of the selected frequencies is prohibited from subsequent

selection in at least a portion of the time period T." (*See* Ex. 1 ('346 patent) at claims 3, 5, 15, and 17). I understand that such import of language from other parts of the claims is improper.

101. Moreover, in my opinion, the patentee did not disclaim or limit the scope of the claims, as Dr. Ding contends.

102. More specifically, Dr. Ding contends that "if the 'N' and 'F' terms are construed in a way that would allow a frequency hopping system to select any frequency more than once during a particular time period T, prior art systems like Munday or Haartsen would cover the claims." (Ding Decl. at ¶¶ 67-68). I disagree. As explained above, in the April 2005 Request, the applicant clarified that "neither Munday nor Haartsen, taken separately or in combination, discloses or suggests *such* a prohibition on frequency selection [over at least a portion of time period T]. Instead, it appears that after a set of frequencies is selected in Munday or Haartsen any frequency within the set can be re-selected without prohibition." (Ex. 12 (April 2005 Request) at pp. 11-12 (emphasis added)). In my opinion, a POSITA, reading the prosecution, would understand that the prohibition recited in the claim is not limited to the entire time period T. (*See supra* at ¶¶ 57, 58, 78-82). Furthermore, there were no amendments made to "N" and "F" limitations.

3. The "N/F Frequency" Terms Are Not Indefinite.

103. Dr. Ding contends that, despite a definition of "N" in the claims and specification, "the claims give no guidance as to whether N refers to any or all of: 1) all frequencies in nature; 2) all frequencies allowed by government regulations; 3) all frequencies available to a particular communications standard; or 4) all frequencies currently being used for hopping according to the claimed algorithm." (Ding Decl. at ¶ 58). I disagree.

104. More specifically, the "N" terms are clearly defined in the claims and specification as explained above. Similar to the "time period T" terms, these terms are variables that are well-

understood in the context of frequency hopping used in communication devices. *See supra* at ¶¶ 91, 93.

105. I also do not agree that "N" is so broad as Dr. Ding contends in paragraph 58 of his declaration. Dr. Ding reads these terms out of a context. I disagree. N is the number of frequencies currently used for frequency hopping by the algorithm. (Ex. 1 ('346 patent) at 3:61-62; claims 1, 4, 5, 7, 13, 16, 17, and 19). Furthermore, a POSITA would have known that, in GSM, N can be, at most, 64, but if a cellular operator does not have sufficient spectrum, N can be less than 64. However, contrary to Dr. Ding, there is nothing in the patent that "defines N in a manner that is narrower than, for example, a particular wireless standard. The fact that, in GSM, N *can* be smaller than 64, does not require N to be necessarily smaller than 64.

106. With regard to "F", Dr. Ding similarly contends that if "F" is not limited in the proposed manner, "POSITA would have no way of knowing what F means, and the claims would not have had a definite plain and ordinary meaning." (Ding Decl. at ¶ 66). I disagree.

107. In my opinion, a POSITA would know how to derive both "N" and "F" in the context of the claims and the specification. The '346 patent claims and specification provide a detailed description of the claimed pseudo-random frequency hopping algorithm over which these terms apply. (*See supra* at ¶ 91; Ex. 1 ('346 patent) at Abstract, 2:31-48, 3:13-56, 3:57-4:10, 5:3-27, 5:42-6:42; claims 1-5, 7, 10, 11, 13-17, and 19, Fig. 3). The '346 patent specification further provides a specific illustration of how to derive "N"/"F" values and describes a protocol for deriving their range in the context of specific wireless communication systems. (*See supra* at ¶ 91; Ex. 1 ('346 patent) at 5:3-6:53; 6:62-7:19; Fig. 5; Fig. 6). In light of the specification and claims, a POSITA would understand how to derive the value of these terms in the context of the claims depending on the specific wireless communication system being implemented.

108. Just as Dr. Ding provided one illustration in his frequency hopping algorithm where N is 64 (Ex. 15 (Ding 2007) at 5498), the ’346 patent also describes two examples, one in which the total number of frequencies available to hop, i.e., N is 4 (Ex. 1 (’346 patent) at 3:42-46), and another where N is 8 (*id* at 3:46-52; 5:21-6:42; Fig. 3; Fig. 6). (*See supra* at ¶¶ 52, 53, 93). The ’346 patent also states “[i]t should be noted that although the negative effects of frequency repetitions decrease for GSM hopping sets with larger values of N, e.g., N=12, the inventive concept ***still provides improvement***.” (*Id*. at 3:52-56 (emphasis added)). In my opinion, a POSITA in light of the specification would have understood that the claims inform those skilled in the art about the scope of the invention with reasonable certainty. In my opinion, a POSITA in light of the specification would have understood that the ’346 patent specification provides sufficient guidance for a POSITA to derive the values of these terms in the context of the claims and specific wireless system used.

C. “AT LEAST ONE OF THE SELECTED FREQUENCIES IS PROHIBITED FROM SUBSEQUENT SELECTION” (ALL ASSERTED CLAIMS)

Claim Term	WSOU’s Proposed Construction	Canon’s Proposed Construction
“at least one of the selected frequencies is prohibited from subsequent selection”	Plain and ordinary meaning; or, if the Court deems a construction is necessary: “at least one of the selected frequencies is not allowed to be subsequently selected”	“a frequency that has already been used during the time period T is prohibited from being re-used during the remainder of the time period T solely because it has been previously used”

109. In my opinion, this term needs no construction; it should be given its plain and ordinary meaning. In my opinion, the plain and ordinary meaning of this term is “at least one of the selected frequencies is not allowed to be subsequently selected.” In my opinion, this construction is supported by the intrinsic record. For example, the Summary of the Invention

Section of the '346 patent describes that "[i]n particular, prior selected frequencies are temporarily prohibited from being selected again from the hopping set." (Ex. 1 ('346 patent) at 2:37-48). For example, the '346 patent describes a set B as "the set of (N−F) frequencies over which a wireless endpoint is not currently allowed to hop," or as "a set of prohibited frequencies." (*Id.* at 4:5-6, 8; *see also id.* at claims 1-5, 7-9, 11, 13-17, and 19; Ex. 12 (April 2005 Response) at pp. 11-12).

110. Dr. Ding does not provide an opinion with respect to this term because Dr. Ding "was not asked to render an opinion on this term." (Ding Decl. at ¶ 70). However, I understand that Canon has proposed an alternative construction in its Opening Claim Construction Brief. (Op. Brief at pp. 17-19). I have reviewed Canon's proposed construction and its support. Canon's proposed construction is improper.[6]

111. More specifically, Canon's proposed construction improperly includes two limitations: (i) that "a frequency that has already been used during time period T is prohibited from being reused during the remainder of the time period T"; and (ii) that said frequency is "prohibited from being reused *solely* because it has been previously used." (Op. Brief at pp. 17-19 (emphasis added). In my opinion, these limitations directly contradict the plain language of the claims. As stated above, the asserted claims state that "at least one of the selected frequencies is prohibited from subsequent selection *over some portion* of the time period T", but do not require that *each* previously selected frequency is prohibited from being repeated over the *entire* time period T.

112. Canon contends that during the '346 patent's prosecution, the patentee purportedly "limited" the claims "consistently" to "an algorithm in which a frequency that has been used for transmission cannot be repeated during the amount of time it takes a frequency hopping system to

[6] I reserve the right to supplement my opinions based on any additional reasoning or explanation provided Dr. Ding or any other Canon representative.

use each channel available for frequency hopping once." (Op. Brief at p. 17). But as explained above, that is incorrect. (*See supra* at ¶¶ 50-52, 57, 58, 78-82).

113. Canon further contends that the patentee's purported statements during prosecution requires a reading that: "a frequency that has already been used during the time period T is prohibited from being re-used ***during the remainder of the time period T <u>solely</u> because it has been previously used***." (*Id.*) For the reasons explained above, I disagree. (*Supra* at ¶ 55). In my opinion, that would contradict the claim language because the claims use the term "selected" to refer to the frequency(ies) that should be prohibited from being re-selected during at least a portion of the time period T. For example, there could be an example where, during a frequency hopping, a frequency is "selected" but not used for a number of different reasons. Canon has no basis to limit the claim scope to the proposed "sole" reason for prohibition from reselection.

D. "PSEUDORANDOM[LY]" (ALL ASSERTED CLAIMS)

Claim Term	WSOU's Proposed Construction	Canon's Proposed Construction
"pseudorandom[ly]"	Plain and ordinary meaning; or, if the Court deems a construction is necessary: "appears to be patternless"	"a selection generated by an algorithm that approximates a random selection by avoiding a regular pattern of selections when the algorithm is used repeatedly"

114. In my opinion, this term "pseudorandom[ly] needs no construction; it should be given its plain and ordinary meaning because it is well-understood in the art. In my opinion, the plain and ordinary meaning of this term is "appears to be patternless". This meaning is consistent with the specification. (*See, e.g.*, Ex. 1 ('346 patent) at 2:37-48; *see also id.* at Abstract, 2:37-48, 4:11-67; Claims 1-4, 7, 11, 13-16, and 19; Ex. 8 August 2004 Response) at p. 11). By May 2001,

the meaning of the term "pseudorandom[ly]" would have been well-understood by a POSITA and used routinely in publications, books, and literature concerning pseudorandom frequency hopping.

115. However, Dr. Ding contends that a POSITA have understood the term "pseudorandom[ly]" to mean "a selection generated by an algorithm that approximates a random selection by avoiding a regular pattern of selections when the algorithm is used repeatedly." (Ding Decl. at ¶ 71). I disagree with that proposed construction.

116. First, that proposed construction improperly incorporates the definitional characteristics of the term "random" by requiring the avoidance of regular patterns of selection. In addition, there is nothing in the claim or the specification that requires that the algorithm be used repeatedly. Nothing in the intrinsic record supports that the frequency selection be actually random. And, Dr. Ding fails to cite to any support. In fact, this proposed language is inconsistent with the claim language. The term "pseudorandom[]" is used in the same way throughout the specification claims and file history. (Ex. 1 ('346 patent) at 2:37-48; *see also id*. at Abstract, 2:37-48, 4:11-67; Claims 1-4, 7, 11, 13-16, and 19; Ex. 8 (August 2004 Response) at p. 11.

117. In my opinion, a POSITA would have understood that when a pseudorandom "algorithm is used repeatedly," it does not necessarily "avoid[]a regular pattern of selections." That is because, the repeated use of an algorithm starting from an initial state will tend to reproduce an identical pattern. Thus, "avoiding a regular pattern of selections" can contradict the language "when the algorithm is used repeatedly."

118. Additionally, the language "approximates a random selection" is vague. It appears to introduce a criterion for closeness to a random selection. There is no support, either in the specification or in the claims, for introducing this criterion.

119. Moreover, Dr. Ding opines that a POSITA would not purportedly consider WSOU's construction, "appears to be patternless" to be "acceptable." (Ding Decl. at ¶ 73). Dr. Ding contends that "a selection that merely 'appears' to be patternless, as opposed to actually being patternless would encompass subject matter that is not 'pseudorandom.'" (*Id.*) Dr. Ding offers an example of a selection that "might 'appear' to be patternless," but would not be purportedly "pseudorandom" is that of a string of numbers resulting from dividing 1 by 13, which is 0.076923076923…. (*Id.*) I disagree that a POSITA would consider the selection in this example to "appear [] patternless." In my opinion, it generates a regular pattern. Additionally, the '346 patent specification provides a detailed description of the algorithm that is implemented in the pseudorandom selection. (*See, e.g.*, Ex. 1 ('346 patent) at 3:57-5:2). In my opinion, a POSITA in light of the specification would find the construction "appears to be patternless" acceptable.

120. Dr. Ding also contends that because the applicant amended claims during prosecution to include "pseudorandom[ly]" in response to certain objections over prior art, the Court should adopt Canon's construction. I disagree. I reviewed the prosecution history. The fact that "pseudorandom[]" was added cannot be used to limit the scope of that term in the manner Dr. Ding contends.

121. Dr. Ding offers dictionary definitions for "pseudorandom" and "random," to support Canon's proposed construction. (Ding Decl. at ¶ 78). Those definitions support the plain and ordinary meaning of the term to be "appears to be patternless."

122. By May 2001, several pattern-detection tests were known to a POSITA. A POSITA would have considered a sequence sufficiently random, i.e., pseudorandom, when the pattern-detection tests fail to detect a pattern.

XII. LIST OF EXHIBITS

123. I cite to the following exhibits in this declaration.

Ex.	Description
Ex. 1	U.S. Patent No. 7,054,346, dated May 30, 2006 ("Balachandran et al.") bearing production numbers WSOU-CANON-0000001 - WSOU-CANON-0000012
Ex. 5	Office Action Summary, dated May 20, 2004, an excerpt from the file history of U.S. Patent No. 7,054,346 bearing production numbers WSOU-CANON-0000220 - WSOU-CANON-0000231
Ex. 6	U.S. Patent No. 4,654,859, dated March 31, 1987 ("Kung")
Ex. 7	U.S. Patent No. 5,541,954, dated July 30, 1996 ("Emi")
Ex. 8	Amendment and Response, dated August 16, 2004, an excerpt from the file history of U.S. Patent No. 7,054,346 bearing production numbers WSOU-CANON-0000235 - WSOU-CANON-0000247
Ex. 9	Office Action Summary, dated January 7, 2005, an excerpt from the file history of U.S. Patent No. 7,054,346 bearing production numbers WSOU-CANON-0000253 - WSOU-CANON-0000262
Ex. 10	U.S. Patent No. 5,377,221, dated December 27, 1994 ("Munday")
Ex. 11	U.S. Patent No. 6,345,066, dated February 5, 2002 ("Haartsen")
Ex. 12	Request for Reconsideration, dated April 5, 2005, an excerpt from the file history of U.S. Patent No. 7,054,346 bearing production numbers WSOU-CANON-0000265 - WSOU-CANON-0000277
Ex. 13	Notice of Allowability, dated December 15, 2005, an excerpt from the file history of U.S. Patent No. 7,054,346 bearing production numbers WSOU-CANON-0000341 - WSOU-CANON-0000353
Ex. 14	Brief of Appeal on behalf of Appellant, dated April 29, 2005, an excerpt from the file history of U.S. Patent No. 7,054,346 bearing production numbers WSOU-CANON-0000285 - WSOU-CANON-0000319
Ex. 15	Ling Q., Li T., and Ding Z., "A Novel Concept: Message Driven Frequency Hopping (MDFH)," 2007 IEEE International Conference on Communications, Glasgow, Scotland, 24-28 June 2007, pp. 5496-5501

XIII. SUPPLEMENTATION

124. I understand that after I submit my Declaration, Canon will submit its reply claim construction brief further explaining its positions on the meaning of the disputed terms. I also understand that after I submit my Declaration, Canon may submit declarations of its own expert concerning the meaning of the disputed claim terms. I therefore reserve my right to consider and address Canon's and its expert's positions at that time, and supplement my opinions accordingly.

125. I reserve the right to supplement or amend my opinions in response to opinions expressed or positions taken by Canon's experts, or in light of any additional evidence, testimony, discovery, or other information that may be provided to me after the date of this declaration. In addition, I reserve the right to consider and testify about issues that may be raised by Canon's fact witnesses and experts at any hearing or in any expert reports. I also reserve the right to modify or to supplement my opinions as a result of ongoing fact and expert discovery or testimony at trial.

126. I further reserve the right to present any tutorials regarding the background technology and terminology in connection with the opinions in this Declaration, any supplemental declarations, and/or expert reports that I may prepare in this case. I reserve the right to use demonstrative exhibits and/or refer to publicly available information, including any technical publications, such as books and articles, to aid my testimony, and accordingly reserve the right to prepare exhibits and demonstrative evidence for any hearing pursuant to the schedule set by the Court.

127. I expressly reserve the right to amend or supplement my opinions in this case when additional information is made available to me.

* * *

128. This declaration is based on my personal knowledge, and if called as a witness, I would and could competently testify regarding the facts stated herein.

I declare under the penalty of perjury of the laws of the United States that the foregoing statements made in this Declaration are based on my own knowledge and that all opinions given are my own.

Dated: September 15, 2021

Todor Cooklev, Ph.D.

APPENDIX A

Todor Cooklev, PhD.

Curriculum Vitae

Personal

1336 Sycamore Hills Parkway, Fort Wayne, IN 46814
Contact e-mail: tcooklev@gmail.com
Cell: 925-984-5283

Citizenship: United States (by naturalization)

Professional experience

2016 – **Harris Professor of Wireless Communication and Applied Research,** *Purdue University Fort Wayne, Indiana*

- Endowed faculty appointment and appointment to the Purdue Graduate School
- Research on most aspects of wireless systems, including hardware, signal processing, and software techniques, in particular for software-defined radios.
- Courses:
  ECE 428 Communication Systems
  ECE 549 Software-Defined Radio
  ECE 543 Wireless Communications and Networks

2010 – 2016 **ITT Associate Professor of Wireless Communication and Applied Research,** *Purdue University Fort Wayne*

2008 – **Director, Wireless Technology Center**
Purdue University Fort Wayne

2005 – 2008 **Consultant, Hitachi America Ltd., San Jose, California**

- Voting Member, IEEE 802.11 WG; participated in the work on several 802.11 amendments
- Chair, IEEE 802.11 VTS Study Group; responsible for the proposal and approval to create a Task Group that lead to the IEEE 802.11aa standard

2011 – 2012 **Consultant, Hitachi America Ltd., San Jose, California**

- Attended meetings of the 3GPP RAN1 standardization committee in Dresden, Germany, Jeju Island, Korea, Prague, Czech Republic, and Qindao, China, 2012.
- Contributed to several documents submitted to 3GPP

2006 – 2008 **Consultant,** *Datamars, Lugano, Switzerland*

- Evaluated and produced reports on certain wireless technologies and standards
- Participated in the IEEE 802.15.4f committee

2004 – 2006 **Consultant,** *Leica Geosystems, Switzerland*
- IEEE 802.16 (WiMAX) and related technologies

2005 – 2007 **Technical Advisory Board Member**, *Doceotech, San Ramon, CA*

2002 – 2008 **Assistant Professor** with tenure (2008), *San Francisco State University.*

2000 – 2002 **Member of the Technical Staff**, *Aware, Inc., Bedford, MA and Lafayette, CA*
- Worked on DSL standards. Participated in the International Telecommunications Union, Study Group 15, Question 4. Chaired the session on coding for DSL at the session in Antwerp, Belgium, June 2000. Participated in the Telecommunications Industry Association T1E1 Committee on DSL
- Developed advanced coding and decoding methods for DSL
- Worked on the design of an IEEE 802.11a chipset.
- Voting member, IEEE 802.15; Co-Founder and First Vice-Chair of IEEE 802.15.3 (High-data rate wireless personal area networking

1998-1999 **Consultant**, *Quantronix, Framingham, Utah*
- Image processing; developed software for edge detection and wrote a report

1996-1997 **Consultant**, *Communications Research Center, Government of Canada.*
- Designed digital filter banks for communication systems and wrote two technical reports

1996-1999 **Senior Engineer,** *3Com Corporation*
- Worked on V.90 voice-band modems
- Implemented data compression and other signal processing algorithms V.42 and V.42bis
- Worked on the Bluetooth Standard, one of the first contributors to the Host Controller Interface of Bluetooth.
- Participated in the Bluetooth/IEEE group, which drafted the license agreement between Bluetooth and the IEEE 802, which in turn led to the establishment of the IEEE 802.15 Working Group.

Grants Awarded

1. National Science Foundation S^2ERC I/UCRC, “FPGA implementation of shared-memory middleware”, 2017-2019, PI
2. National Science Foundation S^2ERC I/UCRC, “Shared-memory middleware”, 2016-2017, PI
3. City of Fort Wayne, Economic Development Fund, 2013-15, co-PI.
4. Allen County Capital Improvement Board (CIB), 2013-15, co-PI

5. U.S. Defense Advanced Research Projects Agency (DARPA) Small Business Technology Transfer (STTR) Phase I "A flexible and extensible solution to incorporating new RF devices and capabilities into EW/ISR networks, co-PI, August 2013 – February 2014.

6. National Science Foundation S^2ERC I/UCRC, "The performance of middleware solutions for SDR", 2013-2014, PI

7. National Science Foundation S^2ERC I/UCRC, "Cognitive decision applications for embedded use," 2011-2012, PI

8. Visiting Fellowship, National Institute of Communication Technology (Japan), 2011

9. National Science Foundation S^2ERC I/UCRC, "Signal processing techniques for multicarrier modulation," 2009-2011, PI

10. NMDG, Belgium, laboratory grant 2010, PI

11. National Science Foundation, Professional Science Master's Program, MS in engineering, with concentration in wireless and systems engineering, 2010-2013, Co-PI.

12. Emona Instruments, Sydney, Australia, Laboratory exercises in communications, Principal Investigator, 2008.

13. Lilly Endowment, wireless laboratory grant, 2010, PI.

14. ITT (now Harris) Communications Systems, 2007-2011, PI.

15. State of Indiana, workforce development, 2008-2010, PI

16. National Science Foundation DUE-0442313, "Standards in Education for Product, Process, and Service Design and Development: A Proof-of-Concept Project," 2005-2008, PI.

17. France Telecom, Paris, France, "New methods for multicarrier modulation for high data-rate wireless systems," Principal Investigator, 2006.

18. Agilent Technologies/Sun Microsystems, Palo Alto, CA, "Distributed wireless sensor network for environmental monitoring," Co-principal Investigator, 2005.

19. CSU summer research grant, 2004.

20. U.S. Air-Force Research Laboratory, Wright-Patterson AFB, "Data over voice communications," Principal Investigator, 2004.

Honors and Awards

2012	IEEE Standards Association, "for outstanding contributions to the development of IEEE 802.11aa"
2006	Wireless Educator of the Year Award with the citation "In recognition of the pivotal role of educators in preparing tomorrow's wireless technology leaders".
2005	Duke's Choice Award, Sun Microsystems, (group award)
2003	IEEE Communications Society Oakland/East Bay Chapter Achievement Award, (group award)
1999	3Com Inventor Award
1995-1997	NATO Science Fellowship
1994	IEEE Asia - Pacific Conference on Circuits and Systems Best Paper Award for the paper "Theory of filter banks over finite fields"

Education

1995 *Tokyo Institute of Technology, Tokyo, Japan,*
Doctor of Philosophy in Electrical Engineering

Dissertation: Regular Perfect-Reconstruction Filter Banks and Wavelet Bases

1988 *Technical University of Sofia, Bulgaria,* Dipl. Eng. in Electrical Engineering

Professional Activities

Board Membership:
Board of Governors, IEEE Standards Association, 2021-2022

Committee/Editorial Board Membership:
IEEE Communications Standards Magazine, Series Editor, Wireless and Radio Communications, 2017-

Committee Membership:
- IEEE 802.11 Working Group Voting Member, 2001-2003, 2006-present
- IEEE 802.15 Working Group Voting Member 1999-2001
- Chairman, IEEE Standards in Education Committee, 2006 – present
- Member of the Editorial Board, Journal of Networks.
- 2004-2005 Chairman and 2003-2004 Secretary of the Oakland/East Bay Chapter of the IEEE Communication Society.

Program Committee Membership:
- General Chair, Tactical Communications and Interoperability Conference, 2011
- General Chair, Fort Wayne Wireless Summer School 2009 and 2010
- Program Committee Member, Int. Conf. on Wireless Applications and Computing, 2007.
- Program Committee Member, Int. Conference on WLAN, WPAN, and WMAN, Hawaii, Aug. 2007.

- Program Committee Member, Int. Joint Conf. e-Business and Telecommunications, Barcelona, Spain, 2007.
- Program Committee Member, Int. Conf. Wireless Information Networks and Systems, Lisbon, Portugal, 2006.
- Technical Program Committee Member, Int. Conf. Networking and Services, ICNS 2006, Santa Clara, CA.
- Technical Program Committee Member, Advanced Int. Conference on Telecommunications, AICT, Guadeloupe, French Caribbean 2006.
- Program Committee Member, Int. Joint Conf. e-Business and Telecommunications, Reading, UK, 2005.
- Technical Program Committee Member, Int. Conf. Convergent Services and Next-Generation Networks, June 2005, Chicago, IL.
- Technical Program Committee Member, Int. Conference on Service Assurance with Partial and Intermittent Resources, Lisbon, Portugal, July 2005.
- Technical Program Committee Member, Int. Conf. Telecommunications, 2004, Brazil.
- 3rd Int. Workshop on Signal and Image Processing, Manchester, UK, Special session on wavelets in communication systems, signal and image processing, special session co-organizer, Nov. 1996.

Tutorials at International Conferences

1) T. Cooklev, "Open RF-digital interfaces and wireless ontologies," IEEE BlackSeaCom, 4th International Black Sea Conference on Communications and Networking, Varna, Bulgaria, June 2016.
2) M. Cummings, T. Cooklev, "Software Defined Radio Technology", Tutorial at the 2008 Symposium System on Chip, Tampere, Finland, Nov. 2008.
3) M. Cummings, T. Cooklev, "Software Defined Radio Technology", Tutorial at the IASTED Int. Conference Computer Communications, Palma de Mallorca, Spain, Sept. 2008.
4) M. Cummings, T. Cooklev, "Software Defined Radio Technology", Tutorial at the 2007 International Conference on Computer Design, Squaw Creek, CA 2007.
5) T. Cooklev, "Wireless communication standards: 802.11, 802.15, and 802.16," Int. Conference Telecommunications, Fortaleza, Brazil, Aug. 2004, tutorial.
6) T. Cooklev, "Wireless data communication standards, IEEE Globecom 2003, Dec. 2003, San Francisco, CA, tutorial.

Short Courses and Invited Talks excluding conferences:

1) T. Cooklev, "Open RAN", Technical University of Sofia, Bulgaria, November 2019.
2) T. Cooklev, "Software-defined radio technology," Oulu University, Finland, Oct. 2017.
3) T. Cooklev, "Software-defined radio technology," Aarhus University, Denmark, Oct. 2017.
4) T. Cooklev, "Modern wireless systems," Technical University of Sofia, Bulgaria, 2014.
5) T. Cooklev, "Modern Wireless Systems," Featured faculty presentation, Feb. 2012, IPFW.
6) T. Cooklev, "Software-defined radio technology," Tokyo Institute of Technology, Dec. 2011.
7) T. Cooklev, "Software-defined radio technology," University of Akron, OH, 2010.
8) T. Cooklev, "Modern wireless systems," Catholic University of Leuven, Leuven. Belgium, 2010
9) T. Cooklev, "Modern wireless systems," University of Qatar, Doha, Qatar, 2009.
10) T. Cooklev, "Modern wireless systems," Technical University of Sofia, Bulgaria, 2009.

11) T. Cooklev, "Modern wireless systems: from Marconi's radio to cognitive radio," Sigma Xi presentation, February 2009, IPFW.
12) T. Cooklev "Software-Defined Radio Technology," Talk at IPFW, Oct. 2008.
13) M. Cummings, T. Cooklev, "Software Defined Radio Technology", IEEE Communication Society, Oakland/East Bay Chapter, presentation, Oct. 2007, San Ramon, CA.
14) T. Cooklev, "Engineering Standards in Engineering Education," presentation and a panel participant, Standards Engineering Society Annual Conference, San Francisco, CA, August. 2007. (panelist and presenter)
15) T. Cooklev, "Vector transform for multicarrier modulation", France Telecom, June 2007, Rennes, France.
16) T. Cooklev, "Wireless Communication Standards," Distinguished Lecture, IEEE Communication Society, Oct. 2006, University of Maine.
17) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Short Course, April 2006, Lietuvos Telekomas, Vilnius, Lithuania,
18) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Short Course, Feb. 2006, Austin, TX.
19) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Invited Talk, Dec. 2005, Cisco Systems, San Jose, CA.
20) Wireless local area networks, Hitachi Ltd., Brisbane, CA, June 2005.
21) T. Cooklev, "The IEEE 802.11, 802.15, and 802.16 Families of Standards," Invited Talk, May 2005, Texas Instruments, Dallas, TX.
22) T. Cooklev, "Standards for the Wireless Internet", IEEE Communication Society, Oakland/East Bay Chapter, presentation, January 2005. Freemont, CA.
23) T. Cooklev, "Wireless data communication standards, IEEE Wescon, Aug. 2003, San Francisco, CA, tutorial.
24) Short Course on 802.11, 802.15, 802.16, West Long Branch, NJ, August 2003
25) Wireless data communication standards, Lockheed Palo Alto Research Center, June 5, 2003.
26) Short Course on IEEE 802.11, 802.15, and 802.16, San Francisco, CA, Dec. 2002.
27) Standards for wireless data communications, University of Utah, Salt Lake City, UT, 1999
28) OFDM for wireless communications, 3Com Technology Forum, Boston, MA, Nov. 1998.
29) Filter banks and wavelets: a modern applied mathematics tool, Invited Lecture at the Analysis Day, Department of Mathematics and Statistics, Carleton University, Ottawa, Canada, 1997
30) Filter banks and wavelets for video signal processing, Genesis Microchip Inc, Markham, Ontario, Canada, July 1996.
31) Advanced topics in filter banks, wavelets, and their applications in modern communications systems, CRC, Ottawa, March and August 1996.
32) Digital filter banks and wavelets, Dept. Elect. Eng., University of Ottawa, March 1996.
33) Digital filter banks and wavelets, Dept. Elect. Eng., Queen's University, Kingston, March 1996.
34) Perfect-reconstruction filter banks and wavelet bases and their applications in digital communications, Fujitsu Laboratories, Kawasaki, Japan, July 1994.
35) Fast algorithms for signal processing, Istanbul University, Istanbul, Turkey, Jan. 1994.

Publications

Books and Monographs

1) T. Cooklev, W*ireless communications standards: A Study of IEEE 802.11, 802.15, 802.16*, IEEE Press, New York, NY. 2004.

Chapters in Books

1) Subbu Ponnuswamy, Todor Cooklev, Yang Xiao, and Krishna Sumanth Velidi, "Security in fixed and mobile IEEE 802.16 networks," Chapter 4, *WiMAX/MobileFi: Advanced Research and Technology*, edited by Yang Xiao, Taylor and Francis, January 2008.

2) T. Cooklev and A. Hristozov, "The Software Communications Architecture," in *Resource Management in Future Internet*, edited by Ramjee Prasad, River Publishers, Denmark, 2015.

Journal Papers

1) V. Kolev, T. Cooklev, F. Keinert, *Design of a Simple Orthogonal Multiwavelet Filter by Matrix Spectral Factorization*, Circuits, Systems, and Signal Processing, 2019.

2) Y. Acar and T. Cooklev, "High performance OFDM with index modulation", *Physical Communication*, vol. 32, pp. 192-199, 2019.

3) M. Sherman and T. Cooklev, "Abstract descriptions of spectrum: VITA 49 and IEEE 1900.5.2", *IEEE Communications Standards Magazine*, vol. 2, no. 4, pp. 43-48, December 2018.

4) T. Cooklev, V. Poulkov, D. Bennett, K. Tonchev, "Enabling RF data analytics services and applications via cloudification," *IEEE Aerospace Electronic Systems Magazine*, vol. 33, no. 5-6, pp. 44-55, May-June 2018.

5) V. Kolev, T. Cooklev, F. Keinert, "Matrix spectral factorization for the SA4 multiwavelet," *Journal of Multidimensional Systems and Signal Processing*, vol.29, Issue 4, pp 1613–1641, 2018.

6) H. Dogan, T. Cooklev, and J. Darabi, "Improved low-complexity zero-padded OFDM receivers", *Digital Signal Processing*, vol. 51, pp. 92–100, April 2016.

7) P. Baltiiski, I. Iliev, B. Kehaiov, V. Poulkov, and T. Cooklev, "Long-Term Spectrum Monitoring with Big Data Analysis and Machine Learning for Cloud-Based Radio Access Networks," *Wireless Personal Communications*, vol. 87, issue 3, pp. 815-835, April 2016.

8) T. Cooklev, J. Darabi, C. McIntosh, and M. Mosaheb, "Cloud-based approach for spectrum monitoring," *IEEE Instrumentation and Measurement Magazine*, vol. 18, no. 2, pp. 33-37, April 2015.

9) Sven Bilen, A. Wyglinski, C. Anderson, T. Cooklev, C. Dietrich, B. Farhang-Boroujeny, "On Software-Defined Radio as an integrative educational resource," *IEEE Communications Magazine*, vol. 52, no. 5, pp. 184-193, May 2014.

10) Hakan Yıldız, Yusuf Acar, Todor Cooklev, Hakan Dogan, "Generalized Prefix for Space-Time Block Coded OFDM Wireless Systems over Correlated MIMO Channels," *IET Communications*, vol. 8, no. 9, pp. 1589-1598, June 2014.

11) T. Cooklev, A. Nishihara, "An Open RF-Digital interface for software-defined radios," *IEEE Micro,* vol. 33, no. 6, pp. 47-55, Dec. 2013.

12) T. Cooklev, R. Normoyle, and D. Clendenen, "The VITA 49 RF-digital interface," *IEEE Circuits Systems Magazine*, vol. 12, no. 4, pp. 21-32, Dec. 2012.

13) T. Cooklev, "An improved prefix for OFDM-based cognitive radios", *Electron. Lett.*, vol. 48, No. 4, Feb. 2012.

14) Y. Alqudah and T. Cooklev, "Hands-on open access broadband wireless technology lab", *Int. J. Interactive Mobile Tech.*, Vol. 6, No 4, 2012, pp. 13-18.

15) T. Cooklev, H. Dogan, R. Cintra, H. Yildiz, "Generalized prefix for OFDM wireless systems over quasi-static channels," *IEEE Transactions on Vehicular Technology,* vol. 60, No. 8, pp. 3684 – 3693, *Nov.* 2011.

16) F. Ramirez-Mireles, T. Cooklev, and G. A. Paredes-Orozco, "UWB-FSK: Performance tradeoffs for high-complexity receivers," *IEEE Transactions on Consumer Electronics*, vol. 56, no. 4, pp. 2123-2131, 2010.

17) S. Hossain, D. Batovski, and T. Cooklev, "Eight-channel transmultiplexer with binary matrix sequences," *Assumption Univ. Journal of Technology (Thailand),* vol. 13, No. 4, pp. 193-202, 2010.

18) T. Cooklev, "Engineering standards and engineering education," *Journal of IT Standardization Research*, vol. 8, 2010, pp. 1-10.

19) R. Cintra and T. Cooklev, "Robust image watermarking using non-regular wavelets," *Journal of Signal, Image, and Video Processing*, 2008.

20) T. Cooklev, A. Pakdaman, J. Eidson, "IEEE 1588 over IEEE 802.11 for synchronization of wireless local area nodes," *IEEE Trans. Instrumentation and Measurement*, vol. 56, No. 5, pp. 1632-1639, Oct. 2007.

21) T. Cooklev and A. Nishihara, "Analytic constructions of complementary sequences," *IEICE Trans. Fundamentals*, November 2006.

22) T. Cooklev, "An efficient architecture for orthogonal wavelet transforms," *IEEE Signal Processing Letters*, Feb. 2006.

23) T. Cooklev, "Standards for the wireless Internet," *Annual review of communications*, vol. 57, Dec. 2004.

24) T. Cooklev, G. Berbecel and A. N. Venetsanopoulos, ``Wavelets and differential-dilation equations,'' *IEEE Trans. Signal Processing*, vol. 48, pp. 2258-2268, 2000.

25) T. Cooklev and A. Nishihara, "Biorthogonal coiflets,"*IEEE Trans. Signal Processing*, vol. 47, pp. 2582-2588, 1999.

26) T. Cooklev, A. Nishihara, T. Yoshida, and M. Sablatash, ``Multidimensional two-channel linear phase FIR filter banks and wavelet bases with vanishing moments," *Journal of Multimensional Systems and Signal Processing*, vol. 9, pp. 39-76, January 1998.

27) T. Cooklev, A. Nishihara and M. Sablatash ``Regular orthonormal and biorthogonal wavelet filters," *Signal Processing*, vol. 57, pp. 121-137, Feb. 1997.

28) T. Yoshida, T. Cooklev, A. Nishihara, and N. Fujii, "Design of non-separable 3-D QMF banks using McClellan transformations," *IEICE Trans. Fundamentals*, vol. E79-A, No. 5, May 1996, pp. 716-720.

29) M. Sablatash and T. Cooklev ``Coding of high-quality audio signals by wavelets and wavelet packets," *Digital Signal Processing: A Review Journal*, vol. 6, No. 2, pp. 96-107, April 1996.

30) V. Dimitrov, T. Cooklev, and B. Donevsky ``Number-theoretic transforms over the golden-section quadratic field," *IEEE Trans. Signal Processing*, No. 8, pp. 1790-1797, August 1995.

31) V. Dimitrov and T. Cooklev, ``Hybrid algorithm for computing the matrix polynomial," *IEEE Trans. Circuits Syst.*, No. 7, pp. 377-380, July 1995.

32) V. Dimitrov and T. Cooklev ``Two algorithms for modular exponentiation based on nonstandard arithmetics,'' Special issue on cryptography and information security, *IEICE Transactions on Fundamentals*, Jan. 1995.

33) M. Sablatash , Todor Cooklev and Takuro Kida,``The coding of image sequences by wavelets, wavelet packets and adaptive wavelet packets," *IEEE Trans. Broadcasting*, Dec. 1994.

34) T. Cooklev and A. Nishihara, ``Partial and generalized FFT," *IEICE Trans. on Fundamentals*, Sept. 1994.

35) V. Dimitrov, T. Cooklev and B. Donevsky, "Generalized Fermat-Mersenne number theoretic transforms," *IEEE Trans. Circuits Syst.,* vol. 41, pp. 133-139, Feb. 1994.

36) T. Cooklev, T. Yoshida and A. Nishihara, ``Maximally flat half-band diamond-shaped FIR filters using the Bernstein polynomial," *IEEE Trans. Circuits Syst.,* vol. 40, pp. 749-751, Nov. 1993.

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Expert witness experience

2019 – Expert in the pre-litigation phase

- Law firm: Hagens Berman Sobol Shapiro LLP, Los Angeles, CA

2020 – 2021 Expert for *General Access Solutions,* Dallas, TX

- Law firm: Bartlit Beck, Denver, CO
- Case name*: General Access Solutions, LTD. v. Sprint*
- Civil Action *No. 2:20-cv-00007-RWS* (Eastern District of Texas)

2019 – 2019 Expert for *Bell Northern Research*

2014 – Expert for *TQ Delta,* Austin, TX

- Law firm: McAndrews, Chicago, IL
- Case name: TQ Delta v. Adtran
- *Civil Action No. 14-cv-00954-RGA (D-Del.)*
- *Civil Action No. 15-cv-00121-RGA* (*D-Del.*)

2014 – Expert for *TQ Delta,* Austin, TX

- Law firm: McAndrews, Chicago, IL
- Case name: TQ Delta v. 2Wire
- *Civil Action No. 13-cv-1835-RGA (D-Del.)*

2014 – Expert for *TQ Delta,* Austin, TX

- Law firm: McAndrews, Chicago, IL
- Case name: TQ Delta v. Zhone
- *Civil Action No. 13-cv-1836-RGA (D-Del.)*

2014 – Expert for *TQ Delta,* Austin, TX

- Law firm: McAndrews, Chicago, IL
- Case name: TQ Delta v. Zyxel
- *Civil Action No. 13-cv-2013-RGA (D-Del.)*

2015 – 2019 Expert for *Evolved Wireless,* Austin, TX

- Law firm: Robins Kaplan, Minneapolis, MN
- Civil Actions *No. 15-cv-542-SLR-SRF, No. 15-cv-543-SLR-SRF, No. 15-cv-544-SLR-SRF, No. 15-cv-545-SLR-SRF, No. 15-cv-546-SLR-SRF*, and *No. 15-cv-547-SLR-SRF (D-Del.)* brought against Apple, HTC, Lenovo, Samsung, ZTE, and Microsoft.

2018 –2018 Expert

- Law firm: McKool Smith, Dallas, TX

2013 – 2015 Expert, *Inter-Digital*
- Law firm: Latham and Watkins, Chicago, IL and San Francisco, CA
- Case name: Inter-Digital v. ZTE; Inter-Digital v. Nokia (Microsoft Mobile Oy)
- Civil Actions *No. 13-cv-00009-RGA* and *No. 13-cv-00010-RGA (D-Del.)* brought against ZTE and Microsoft Mobile Oy.

2014 – 2015 Expert, *Core Wireless Licensing, S.à.r.l.*
- Law firm: Bunsow, De Mory, Smith, and Allison, San Francisco, CA
- Civil Actions *No. 6:14-cv-752, No. 2:14-cv-911*, and *No. 2:14-cv-912 (E.D. Tex.)* brought against Apple, Inc. and LG Electronics, Inc.

2014 – 2015 Expert, *Intellectual Ventures I LLC and Intellectual Ventures II LLC*
- Law firm: Dechert, Mountain View, California
- Civil Actions *Nos. 13-cv-01668-LPS, 13-cv-01671-LPS, 13-cv-01670-LPS, 13-cv-01672-LPS, 13-cv-01669-LPS, 14-cv-01229-LPS, 14-cv-01230-LPS, 14-cv-01231-LPS, 14-cv-01232-LPS, 14-cv-01233-LPS*, brought against various AT&T, T-Mobile, Sprint, U.S. Cellular, and Cricket defendants.

2008 – 2010 Expert, *Intel, Santa Clara, CA*
- Law firm: Kirkland & Ellis, San Francisco, CA,

2007 – 2008 Expert, *Intel, Santa Clara, CA*
- Law firm: Keker & Van Nest, San Francisco, CA